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Hamada

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(54) **WIRELESS COMMUNICATION SYSTEM AND METHOD FOR TRANSITIONING BETWEEN WIRELESS COMMUNICATION AND WIRELESS POWER TRANSFER**

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(30) **Foreign Application Priority Data**

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H02J 7/02 (2016.01)

(52) **U.S. Cl.**
CPC ***H04B 5/0037*** (2013.01); ***H02J 7/025*** (2013.01); ***H04B 5/00*** (2013.01); ***H04B 5/0031*** (2013.01); ***H04B 5/0081*** (2013.01); *H04B 5/0075* (2013.01)

(58) **Field of Classification Search**
CPC H04B 5/0037; H04B 5/0031
See application file for complete search history.

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(57) **ABSTRACT**

The object of the invention is to achieve stable operation of a communication device, which includes an information transmission means and a power transmission means while maintaining communication quality. A mobile device of the invention has an information transmission means for executing non-contact transmission, a power transmission means, a first control means for controlling the information transmission means to repeat an active period and a sleep period, and a second control means for controlling the power transmission means to transmit a power during the sleep period.

20 Claims, 11 Drawing Sheets

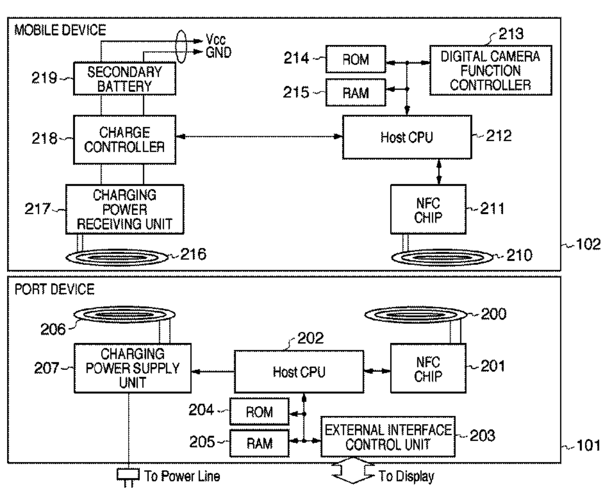

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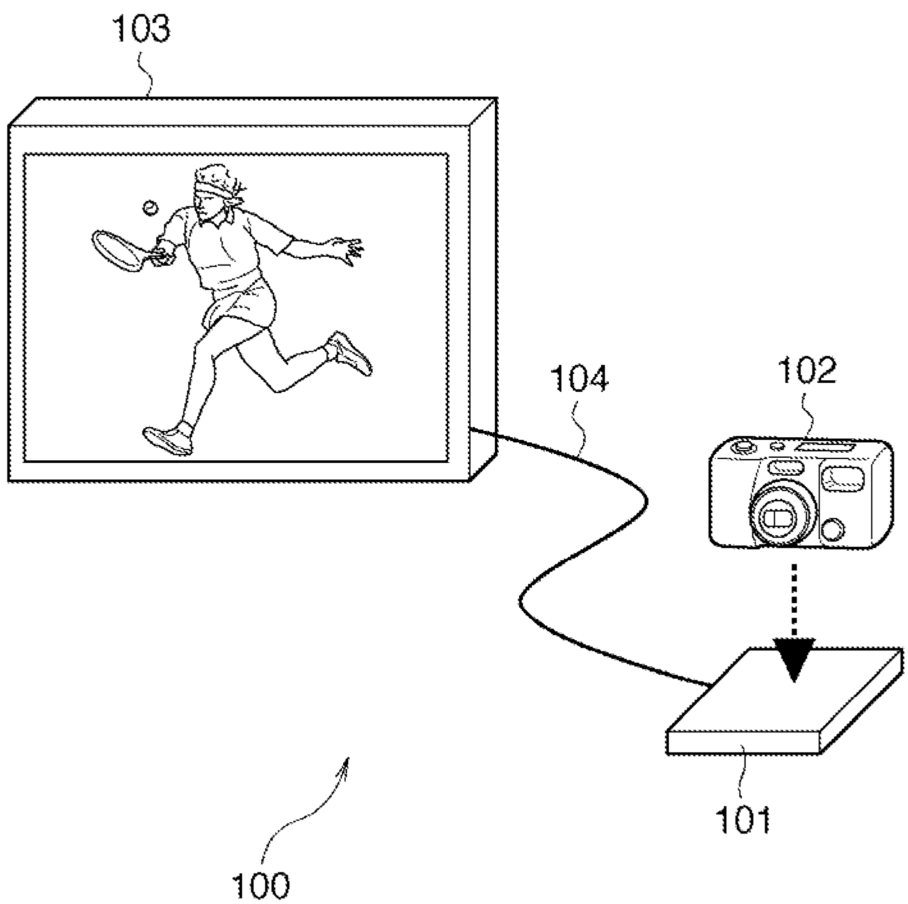
FIG. 1



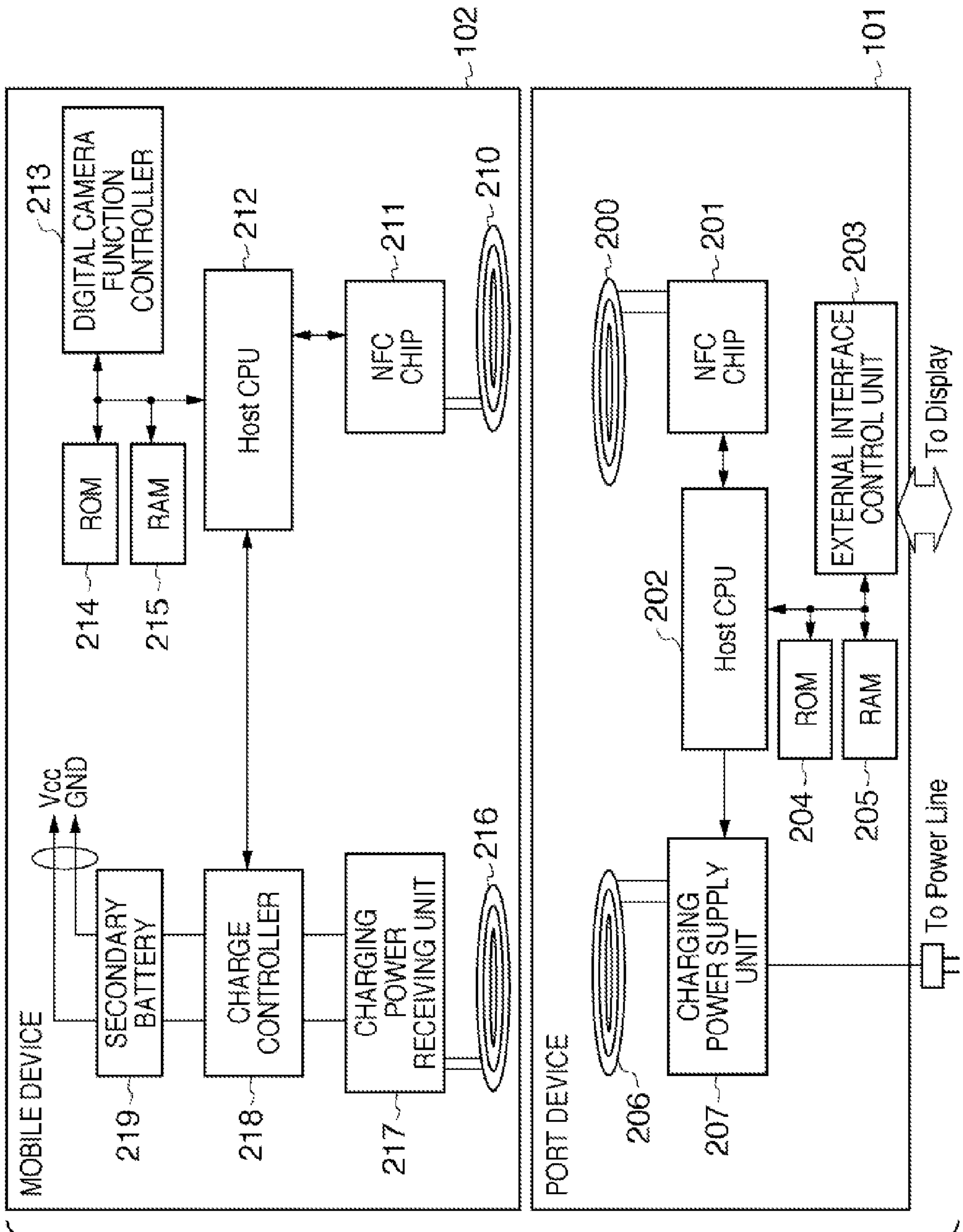

102
MOBILE DEVICE
DIGITAL CAMERA FUNCTION CONTROLLER
213
ROM
214
RAM
215
Host CPU
212
NFC CHIP
211
210
Vcc
GND
SECONDARY BATTERY
219
CHARGE CONTROLLER
218
CHARGING POWER RECEIVING UNIT
217
216
101
PORT DEVICE
200
NFC CHIP
201
Host CPU
202
EXTERNAL INTERFACE CONTROL UNIT
203
To Display
ROM
204
RAM
205
To Power Line
CHARGING POWER SUPPLY UNIT
207
206

FIG. 2

F I G. 3

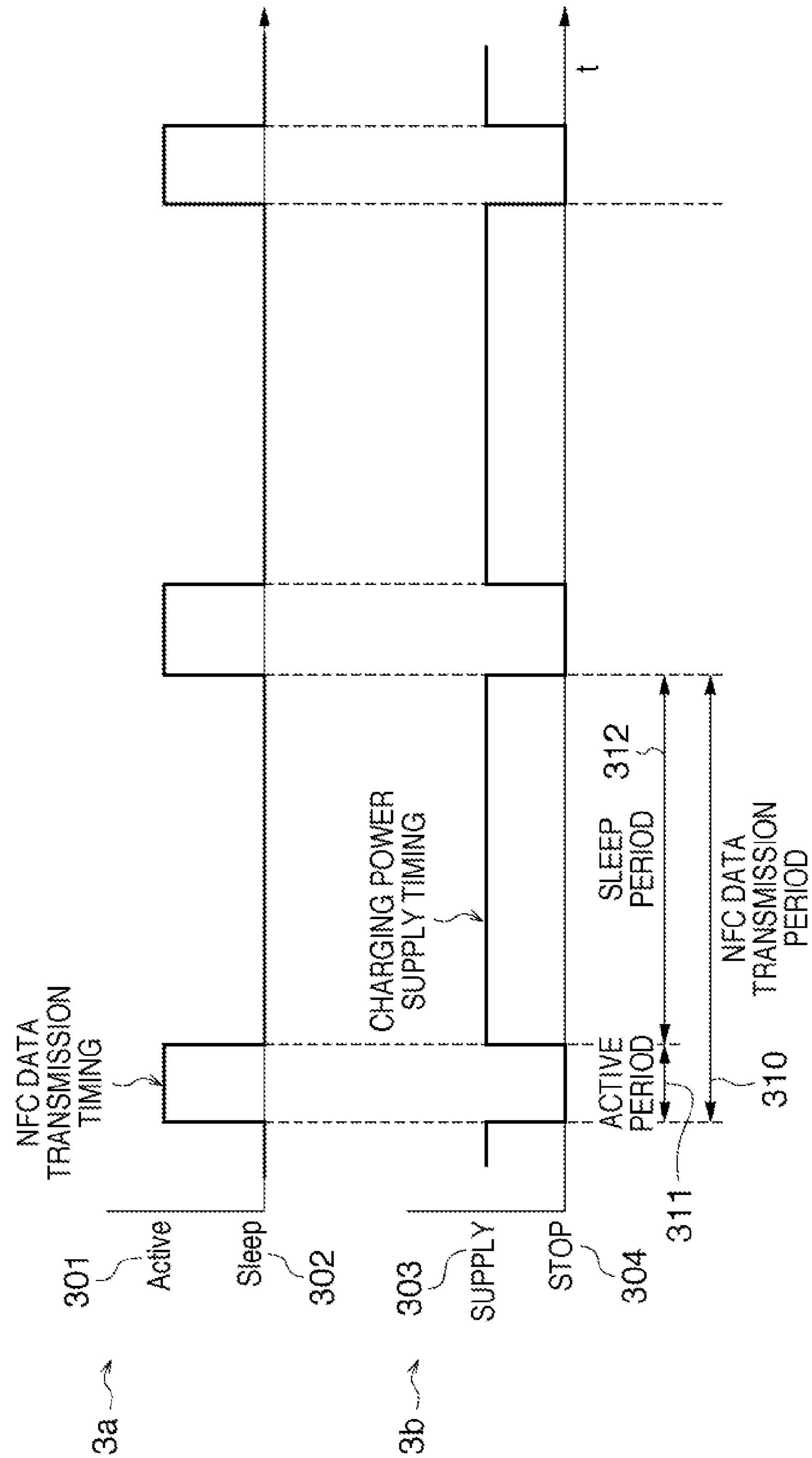

3a
3b
301
Active
Sleep
302
303
SUPPLY
STOP
304
NFC DATA TRANSMISSION TIMING
CHARGING POWER SUPPLY TIMING
ACTIVE PERIOD
SLEEP PERIOD
312
NFC DATA TRANSMISSION PERIOD
310
311
t

FIG. 4

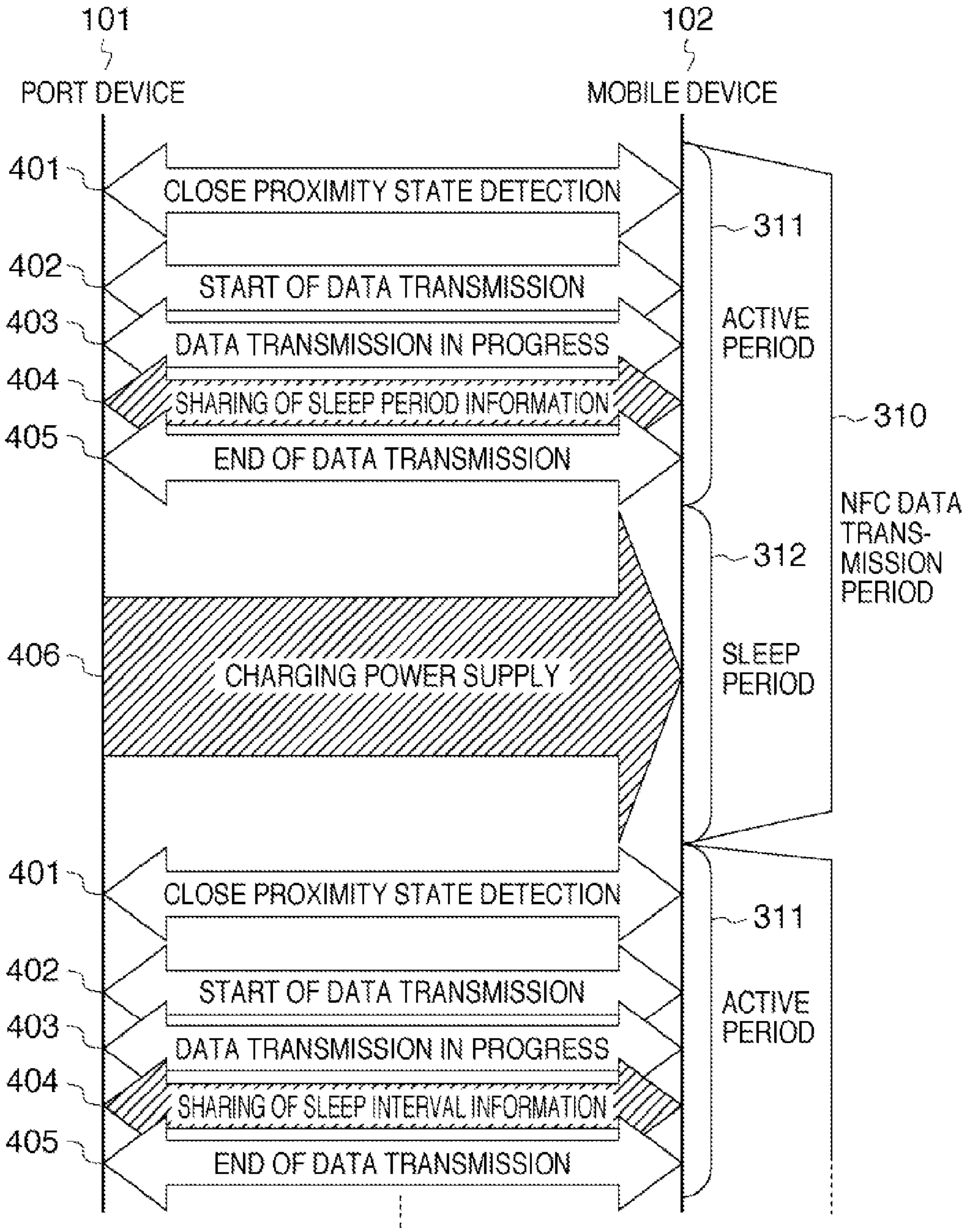

101
PORT DEVICE
102
MOBILE DEVICE
401
CLOSE PROXIMITY STATE DETECTION
402
START OF DATA TRANSMISSION
403
DATA TRANSMISSION IN PROGRESS
404
SHARING OF SLEEP PERIOD INFORMATION
405
END OF DATA TRANSMISSION
406
CHARGING POWER SUPPLY
401
CLOSE PROXIMITY STATE DETECTION
402
START OF DATA TRANSMISSION
403
DATA TRANSMISSION IN PROGRESS
404
SHARING OF SLEEP INTERVAL INFORMATION
405
END OF DATA TRANSMISSION
311
ACTIVE PERIOD
312
SLEEP PERIOD
311
ACTIVE PERIOD
310
NFC DATA TRANS-MISSION PERIOD

FIG. 5

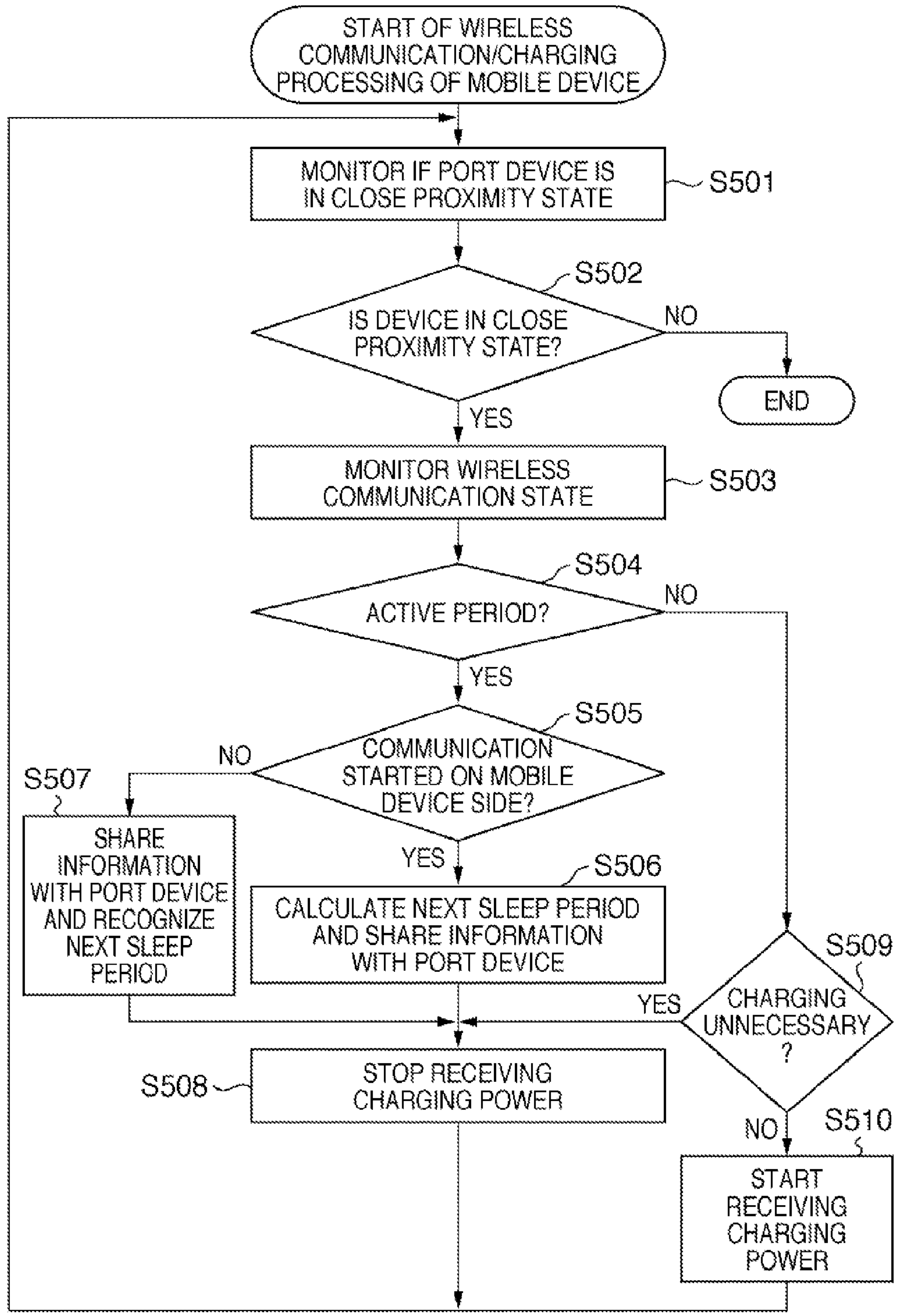
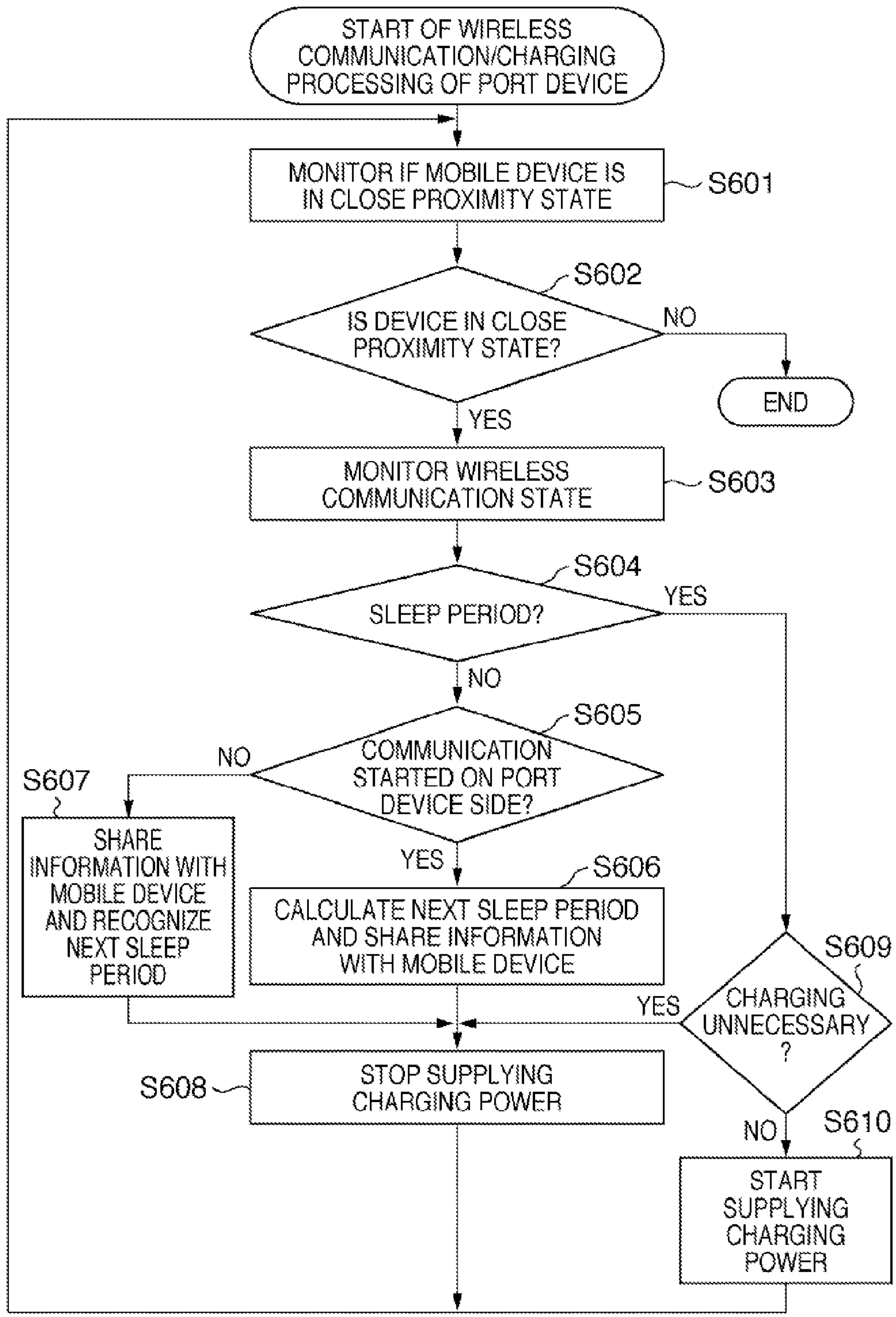

START OF WIRELESS COMMUNICATION/CHARGING PROCESSING OF MOBILE DEVICE
MONITOR IF PORT DEVICE IS IN CLOSE PROXIMITY STATE
S501
IS DEVICE IN CLOSE PROXIMITY STATE?
S502
NO
END
YES
MONITOR WIRELESS COMMUNICATION STATE
S503
ACTIVE PERIOD?
S504
NO
YES
COMMUNICATION STARTED ON MOBILE DEVICE SIDE?
S505
NO
S507
SHARE INFORMATION WITH PORT DEVICE AND RECOGNIZE NEXT SLEEP PERIOD
YES
CALCULATE NEXT SLEEP PERIOD AND SHARE INFORMATION WITH PORT DEVICE
S506
CHARGING UNNECESSARY ?
S509
YES
S508
STOP RECEIVING CHARGING POWER
NO
S510
START RECEIVING CHARGING POWER

FIG. 6



START OF WIRELESS COMMUNICATION/CHARGING PROCESSING OF PORT DEVICE
MONITOR IF MOBILE DEVICE IS IN CLOSE PROXIMITY STATE
S601
IS DEVICE IN CLOSE PROXIMITY STATE?
S602
NO
END
YES
MONITOR WIRELESS COMMUNICATION STATE
S603
SLEEP PERIOD?
S604
YES
NO
COMMUNICATION STARTED ON PORT DEVICE SIDE?
S605
NO
S607
SHARE INFORMATION WITH MOBILE DEVICE AND RECOGNIZE NEXT SLEEP PERIOD
YES
CALCULATE NEXT SLEEP PERIOD AND SHARE INFORMATION WITH MOBILE DEVICE
S606
CHARGING UNNECESSARY ?
S609
YES
STOP SUPPLYING CHARGING POWER
S608
NO
S610
START SUPPLYING CHARGING POWER

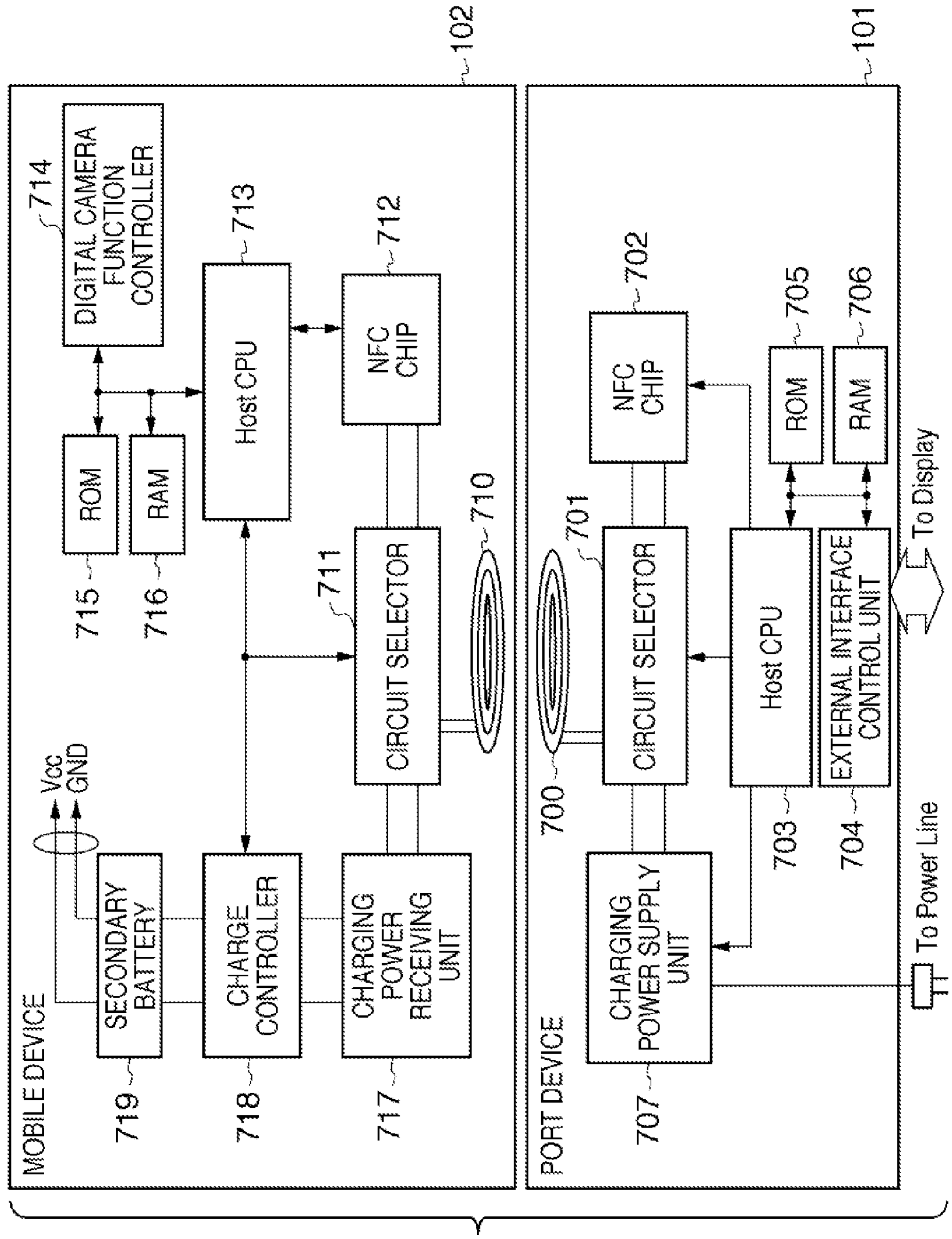

102
MOBILE DEVICE
DIGITAL CAMERA FUNCTION CONTROLLER
714
Host CPU
713
NFC CHIP
712
ROM
715
RAM
716
CIRCUIT SELECTOR
711
710
Vcc
GND
SECONDARY BATTERY
719
CHARGE CONTROLLER
718
CHARGING POWER RECEIVING UNIT
717
101
PORT DEVICE
NFC CHIP
702
ROM
705
RAM
706
701
CIRCUIT SELECTOR
700
Host CPU
703
EXTERNAL INTERFACE CONTROL UNIT
704
To Display
CHARGING POWER SUPPLY UNIT
707
To Power Line

FIG. 7

FIG. 8

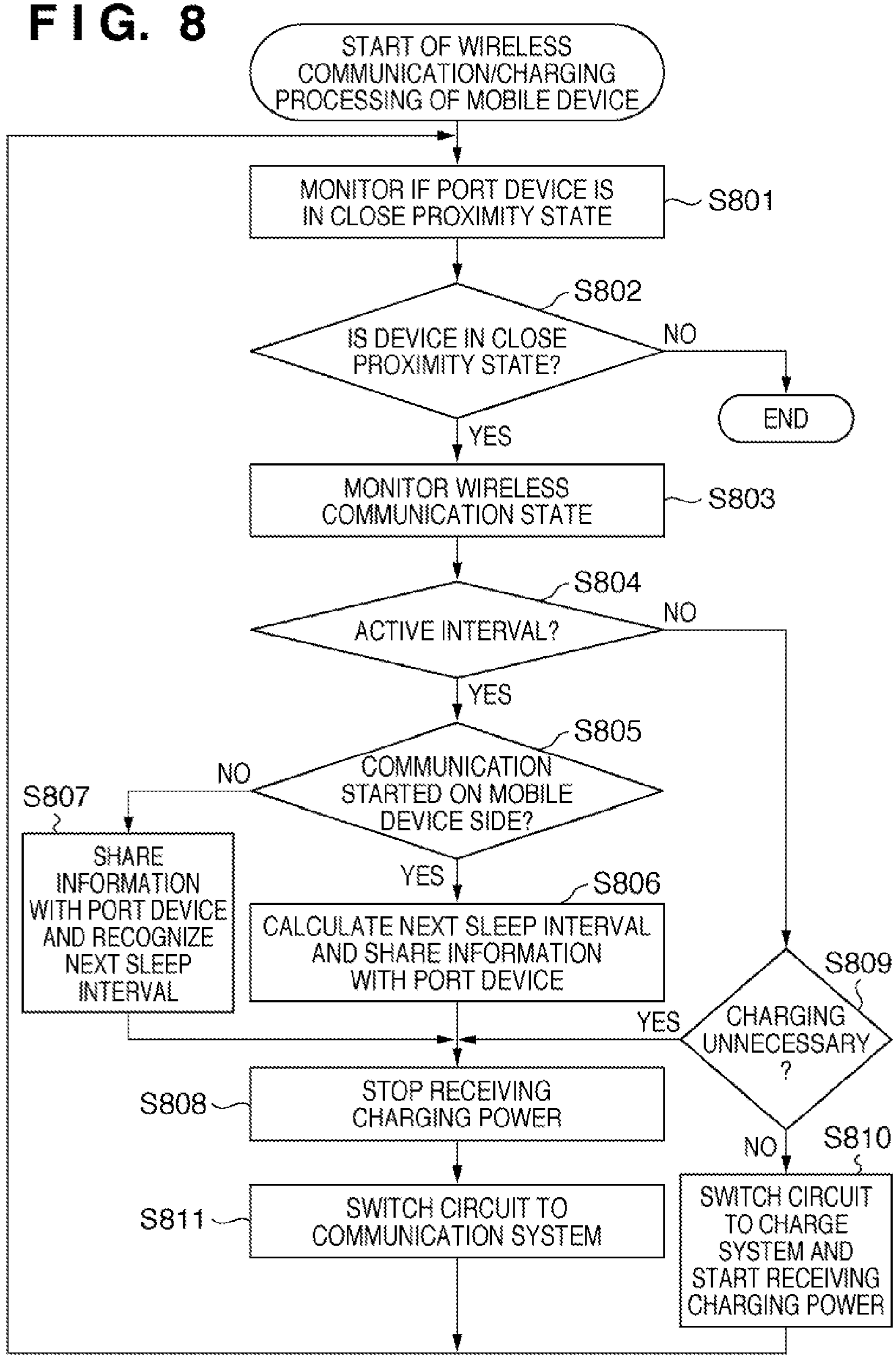
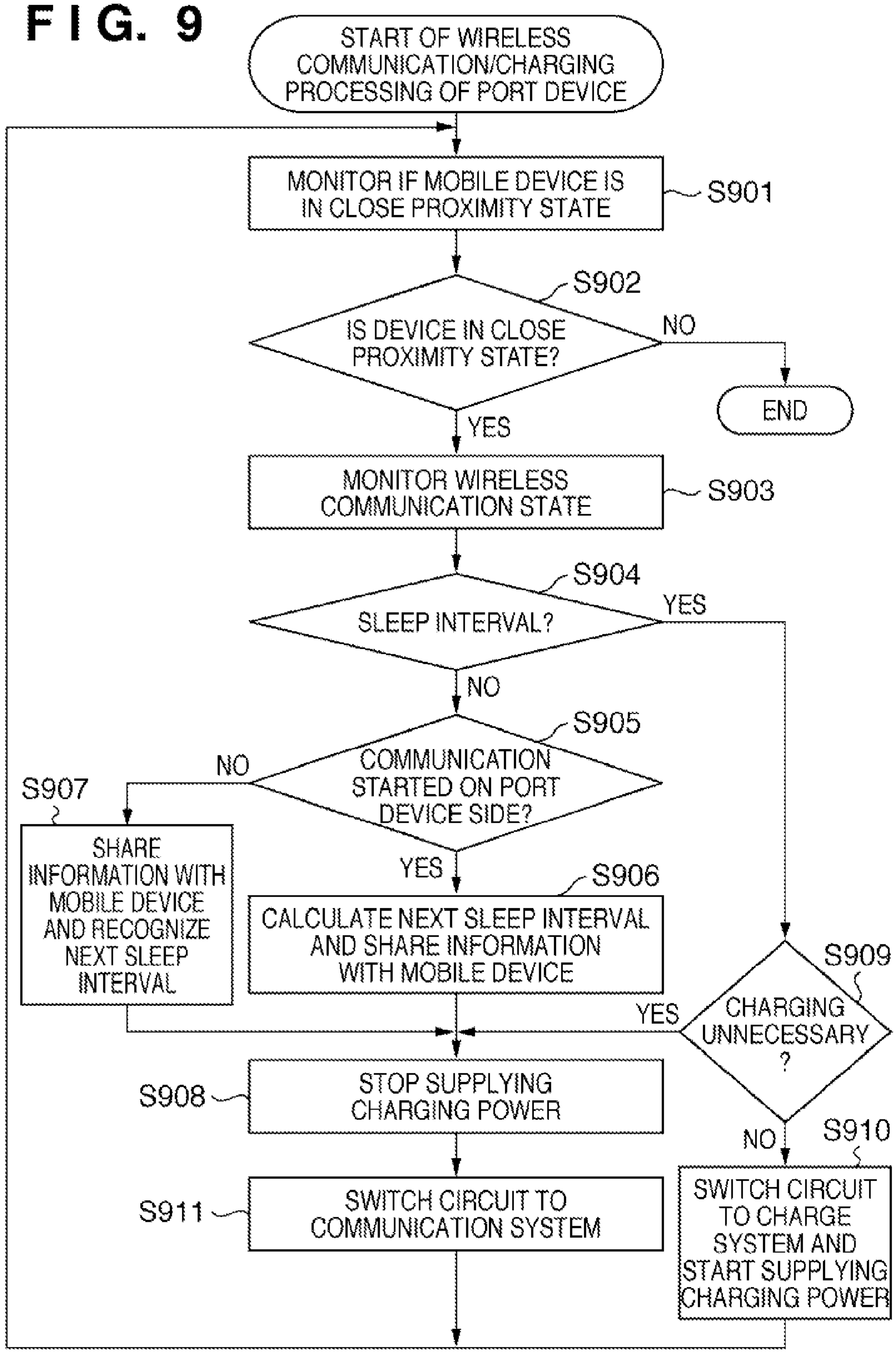
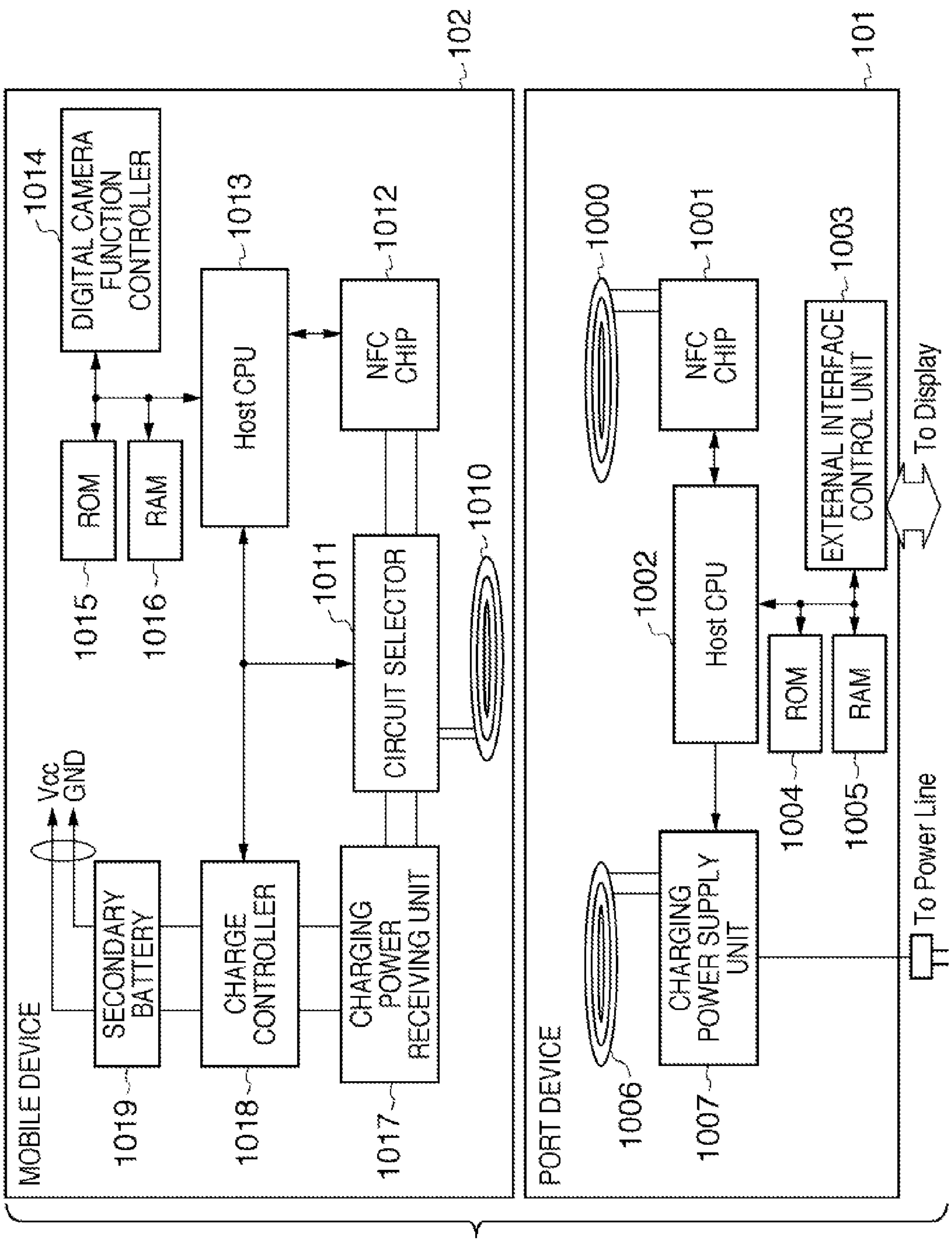

START OF WIRELESS COMMUNICATION/CHARGING PROCESSING OF MOBILE DEVICE
MONITOR IF PORT DEVICE IS IN CLOSE PROXIMITY STATE
S801
S802
IS DEVICE IN CLOSE PROXIMITY STATE?
NO
END
YES
MONITOR WIRELESS COMMUNICATION STATE
S803
S804
ACTIVE INTERVAL?
NO
YES
S805
COMMUNICATION STARTED ON MOBILE DEVICE SIDE?
NO
S807
SHARE INFORMATION WITH PORT DEVICE AND RECOGNIZE NEXT SLEEP INTERVAL
YES
S806
CALCULATE NEXT SLEEP INTERVAL AND SHARE INFORMATION WITH PORT DEVICE
S809
CHARGING UNNECESSARY ?
YES
S808
STOP RECEIVING CHARGING POWER
NO
S810
SWITCH CIRCUIT TO CHARGE SYSTEM AND START RECEIVING CHARGING POWER
S811
SWITCH CIRCUIT TO COMMUNICATION SYSTEM

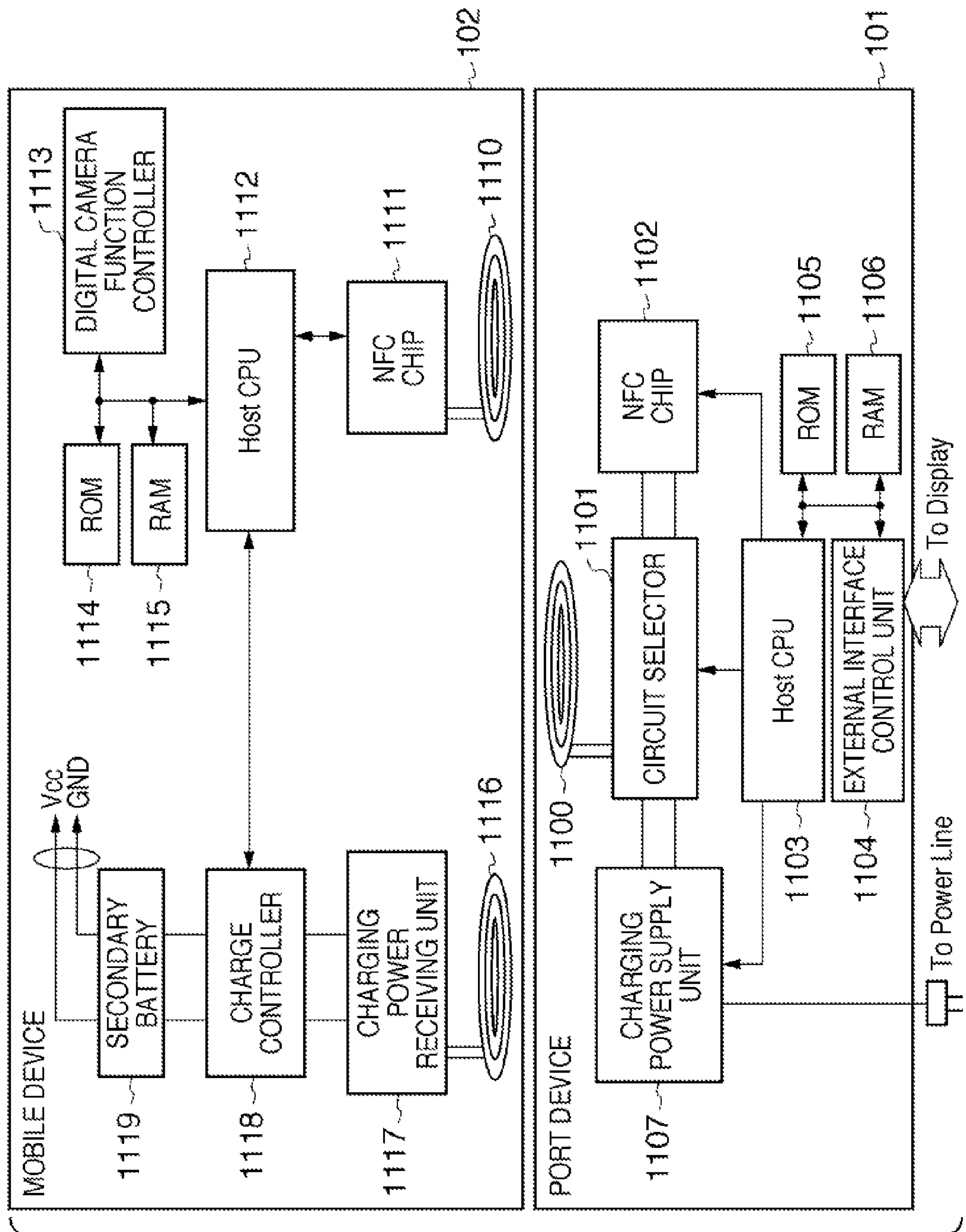
FIG. 9


START OF WIRELESS COMMUNICATION/CHARGING PROCESSING OF PORT DEVICE
MONITOR IF MOBILE DEVICE IS IN CLOSE PROXIMITY STATE
S901
S902
IS DEVICE IN CLOSE PROXIMITY STATE?
NO
END
YES
MONITOR WIRELESS COMMUNICATION STATE
S903
S904
SLEEP INTERVAL?
YES
NO
S905
COMMUNICATION STARTED ON PORT DEVICE SIDE?
NO
S907
SHARE INFORMATION WITH MOBILE DEVICE AND RECOGNIZE NEXT SLEEP INTERVAL
YES
S906
CALCULATE NEXT SLEEP INTERVAL AND SHARE INFORMATION WITH MOBILE DEVICE
S909
CHARGING UNNECESSARY ?
YES
S908
STOP SUPPLYING CHARGING POWER
NO
S910
S911
SWITCH CIRCUIT TO COMMUNICATION SYSTEM
SWITCH CIRCUIT TO CHARGE SYSTEM AND START SUPPLYING CHARGING POWER



102
MOBILE DEVICE
DIGITAL CAMERA FUNCTION CONTROLLER
1014
ROM
1015
RAM
1016
Host CPU
1013
NFC CHIP
1012
CIRCUIT SELECTOR
1011
1010
Vcc
GND
SECONDARY BATTERY
1019
CHARGE CONTROLLER
1018
CHARGING POWER RECEIVING UNIT
1017
101
PORT DEVICE
1000
NFC CHIP
1001
EXTERNAL INTERFACE CONTROL UNIT
1003
To Display
Host CPU
1002
ROM
1004
RAM
1005
CHARGING POWER SUPPLY UNIT
1007
1006
To Power Line

FIG. 10



102
MOBILE DEVICE
DIGITAL CAMERA FUNCTION CONTROLLER
1113
Host CPU
1112
NFC CHIP
1111
1110
ROM
RAM
1114
1115
Vcc
GND
SECONDARY BATTERY
CHARGE CONTROLLER
CHARGING POWER RECEIVING UNIT
1116
1119
1118
1117
101
PORT DEVICE
NFC CHIP
1102
ROM
1105
RAM
1106
1101
CIRCUIT SELECTOR
Host CPU
EXTERNAL INTERFACE CONTROL UNIT
To Display
1100
1103
1104
CHARGING POWER SUPPLY UNIT
1107
To Power Line

F I G. 11

WIRELESS COMMUNICATION SYSTEM AND METHOD FOR TRANSITIONING BETWEEN WIRELESS COMMUNICATION AND WIRELESS POWER TRANSFER

This application is a continuation of U.S. application Ser. No. 12/864,216 which is a National Stage of PCT/JP2009/056414 filed Mar. 24, 2009, the contents of each of which are incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to a control technique of controlling an information transmission means for wirelessly transmitting information and a power transmission means for executing non-contact power transmission between communication devices having the information transmission means and power transmission means.

BACKGROUND ART

Conventionally, as a technique of executing close proximity wireless transfer between communication devices using an electromagnetic coupling, for example, an RFID technique and an NFC technique are well known, and are used as an information transmission means. These techniques are defined by the JIS standard "X6319-4: 2005", the ISO standard "ISO 18092:2004", and the like. Note that RFID is an abbreviation for Radio Frequency IDentification and NFC is en abbreviation for Near Field Communication.

On the other hand, there is known a non-contact power transmission means for transmitting a power between opposing devices using an electromagnetically induced electromotive force to charge secondary batteries arranged within the devices.

A communication device which includes the above-described information transmission means and non-contact power transmission means, and is capable of transmitting information and a power in a non-contact manner is expected to be available.

In the case of such communication device, if the information transmission means and the power transmission means are configured to independently operate, electromagnetic induction in the non-contact power transmission means generates noise in wireless communication using the information transmission means, thereby degrading the communication quality.

Therefore, Japanese Patent Laid-Open No. 2001-102974 has proposed to configure the information transmission means and power transmission means to cooperatively operate, and then execute exclusive control. According to this patent reference, when starting an information transmission operation or power transmission operation on the basis of a user instruction, if either of the means is operating, the other means is controlled to deny or suspend the start of the operation.

In the case of the above-described exclusive control, however, even though the remaining level of the secondary battery of the communication device falls into a critical state during information transmission by the information transmission means, charging is not immediately started. Therefore, the secondary battery may be exhausted during the information transmission, thereby causing the communication device to operate unstably.

DISCLOSURE OF INVENTION

The present invention has been made in consideration of the aforementioned problems, and has as its object to achieve stable operation of a communication device including an information transmission means and a power transmission means while maintaining a prescribed communication quality.

In order to achieve the above object, a communication device according to the present invention has the following arrangement. That is, a communication device comprising: information transmission means for executing non-contact data transmission with another communication device; power transmission means for executing non-contact power transmission with the other communication device; first control means for controlling to repeat a transmission period by the information transmission means and a non-transmission period; and second control means for controlling a power transmission by the power transmission means in synchronization with the repetition of the transmission period and the non-transmission period.

According to the present invention, it is possible to achieve stable operation of a communication device including an information transmission means and a power transmission means while maintaining a communication quality.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. **1** is a view showing an example of a communication system including communication devices according to the first embodiment of the present invention;

FIG. **2** is a block diagram showing the functional components of a port device and mobile device;

FIG. **3** shows timing charts for explaining an outline of wireless communication/charging processing between the port device and the mobile device;

FIG. **4** is a sequence chart showing, in time series, the processing contents executed during active periods and sleep periods;

FIG. **5** is a flowchart illustrating the sequence of the wireless communication/charging processing in the mobile device;

FIG. **6** is a flowchart illustrating the sequence of the wireless communication/charging processing in the port device;

FIG. **7** is a block diagram showing the functional components of a port device and mobile device according to the second embodiment of the present invention;

FIG. **8** is a flowchart illustrating the sequence of wireless communication/charging processing in the mobile device;

FIG. **9** is a flowchart, illustrating the sequence of the wireless communication/charging processing in the port device;

FIG. **10** is a block diagram showing the functional components of a port device and mobile device according to the third embodiment of the present invention; and

FIG. **11** is a block diagram showing the functional components of a port device and mobile device according to the third embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Preferred embodiments of the present invention will be explained below with reference to the accompanying drawings.

First Embodiment

1. Configuration of Communication System

FIG. **1** is a view showing an example of a communication system including communication devices according to the first embodiment of the present invention.

Referring to FIG. **1**, reference numeral **101** denotes a port device (communication device). The port device **101** includes an NFC communication means using the NFC technique, which serves as an information transmission means for executing close proximity wireless transfer using electromagnetic coupling. The port device **101** also includes a charging power supply unit serving as a non-contact power transmission means.

Reference numeral **102** denotes a mobile device (communication device) such as a digital camera. Similar to the port device **101**, the mobile device **102** includes an NBC communication means. The mobile device **102** also includes a charging power receiving unit serving as a non-contact power transmission means.

Reference numeral **103** denotes a display, which is communicably connected with the port device **101** via a wired communication channel **104**.

With the above-described configuration, in a communication system **100**, an image stored in the mobile device **102** is transmitted to the port device **101** by only bringing the mobile device **102** close to the port device **101**. Consequently, the user can readily display the image within the mobile device **102** on the display **103**. In addition, the user can charge a secondary battery within, the mobile device **102**.

2. Functional Components of Communication Device

FIG. **2** is a block diagram showing the functional components of the port device **101** and mobile device **102**. Referring to FIG. **2**, reference numerals **200** and **210** denote wireless communication induction coil units; and **201** and **211**, NFC chips for controlling wireless communication processing using the NFC technique. The induction coil units **200** and **210** and the NFC chips **201** and **211** configure the NFC communication means of the communication devices, respectively.

Reference numerals **206** and **216** denote charging induction coil units; **207**, a charging power supply unit; and **217**, a charging power receiving unit. These components configure the non-contact power transmission means of the communication devices, respectively.

Reference numeral **219** denotes a secondary battery; and **218**, a charge controller for controlling charging of the secondary battery **219** using a power transmitted by the power transmission means.

In the port device **101**, reference numeral **202** denotes a host CPU for controlling the port device **101** as a whole; and **203**, an external interface control unit responsible for wired communication with the display **103**.

Reference numeral **204** denotes a ROM, which stores a program for implementing wireless communication/charging processing (to be described later) and various kinds of data used in executing the program; and **205**, a RAM, which provides a work area when the host CPU **202** executes the program stored in the ROM **204**.

Similarly, in the mobile device **102**, reference numeral **212** denotes a host CPU for controlling the mobile device **102** as a whole; and **213**, a digital camera function controller for causing the mobile device **102** to function as a digital camera.

Reference numeral **214** denotes a ROM, which stores a program for implementing the wireless communication/charging processing to be described later) and various kinds of data used in executing the program; and **215**, a RAM, which provides a work area when the host CPU **212** executes the program stored in the ROM **214**.

3. Outline of Wireless Communication/Charging Processing

An outline of the wireless communication/charging processing between the port device **101** and the mobile device **102** will be explained next.

FIG. **3** shows timing charts for explaining the outline of the wireless communication/charging processing between the port device **101** and the mobile device **102**.

3*a* in FIG. **3** indicates a timing chart showing a timing when the port device **101** and the mobile device **102** use the NFC communication means to execute wireless data (image) transmission. Reference numeral **301** denotes a state in which wireless communication is in an active state (a state in which the mobile device **102** transmits data to the port device **101**); and **302**, a state in which the wireless communication is in a sleep state (a state in which the mobile device **102** does not transmit data to the port device **101**).

As indicated by **3***a* in FIG. **3**, the port device **101** and mobile device **102** are controlled to enter the active state within a certain transmission period (NFC data transmission period) **310**. A transmission period (active period **311**), during which the wireless communication is in the active state, within the NFC data transmission period **310** varies in accordance with a data amount (information amount) transmitted from the mobile device **102** to the port device **101** within the NFC data transmission period **310**.

On the other hand, **3***b* in FIG. **3** indicates a timing chart showing a timing when the secondary battery **219** of the mobile device **102** is charged by transmitting a power using the power transmission means. Reference numeral **303** denotes a state in which the port device **101** supplies a power to the mobile device **102**, and thus the mobile device is being charged; and **304**, a state in which the port device **101** stops supplying the power to the mobile device, and thus the mobile device is not being charged.

As described above, in this embodiment, within the NFC data transmission period **310**, the period other than the transmission period (the active period **311**) during which the wireless communication processing is executed, i.e., a non-transmission period (a sleep period **312**) is assigned to power supply.

4. Details of Wireless Communication/Charging Processing

The details of the wireless communication/charging processing between the port device **101** and the mobile device **102** will be described next with reference to FIGS. **4** to **6**. In this specification, assume that a state in which mobile device **102** is placed on the port device **101** is also a non-contact state. That is, assume that NFC communication by the induction coil units **200** and **210** and the NFC chips **201** and **211** is non-contact communication. Assume also that a charging operation by the induction coil units **206** and **216**, the charging power supply unit **207**, and the charging power receiving unit **217** is a non-contact charge.

FIG. **4** is a sequence chart showing, in time series, processing contents executed during the active periods **311** and the sleep periods **312**. FIG. **5** is a flowchart illustrating the sequence of the wireless communication/charging processing in the mobile device **102**. FIG. **6** is a flowchart illustrating the sequence of the wireless communication/charging processing in the port device **101**.

When each of the mobile device **102** and the port device **101** starts the wireless communication/charging processing, the mobile device **102** monitors in step S**501** whether the port device **101** is in a close proximity state, while the port device **101** monitors in step S**601** whether the mobile device **102** is in a close proximity state.

If the mobile device **102** and the port device **101** respectively determine in steps S**502** and S**602** that the devices are in the close proximity state with each other (**401** in FIG. **4**), the process advances to step S**503** or S**603**. Alternatively, if it is determined that the devices are not in the close proximity state with each other, the wireless communication/charging processing ends.

In steps S**503** and S**603**, the mobile device **102** and the port device **101** monitor the wireless communication state, respectively.

In step S**504**, the mobile device **102** determines whether the wireless communication state is the active state. At this time, the mobile device **102** starts data transmission to the port device **101** (**402** in FIG. **4**). If the data transmission is in progress (**403** in FIG. **4**), the mobile device **102** determines that the wireless communication state is the active state, and the process advances to step S**505**.

On the other hand, the port device **101** determines in step S**604** whether the wireless communication state is the sleep state. At this time, the mobile device **102** starts the data transmission to the port device **101** (**402** in FIG. **4**). If the data transmission is in progress (**403** in FIG. **4**), the port device **101** determines that the wireless communication state is not the sleep state, and the process advances to step S**605**.

In step S**505**, the mobile device **102** determines whether the wireless communication currently in the active state has been started on the mobile device **102** side.

The wireless communication started on the mobile device **102** side indicates that the mobile device **102** side transmits data to the port device **101**, thereby achieving the data transmission between the mobile device **102** and the port device **101**.

If the mobile device **102** determines in step S**505** that the wireless communication has been started on the mobile device **102** side, the process advances to step S**506**. In the case of the wireless transmission started on the mobile device **102** side, the mobile device **102** can recognize a data amount to be transmitted, and therefore calculate a period (active period) necessary for the transmission.

Since the NFC data transmission period **310** is constant as described above, the mobile device **102** can calculate a next sleep period **312** on the basis of the difference between the NFC data transmission period **310** and the active period **311**.

In step S**506**, the mobile device **102** calculates the next sleep period, and transmits the calculation result to the port device **101**. Consequently, information on the next sleep period is shared with the port device **101** (**404** in FIG. **4**).

On the other hand, the port device **101** determines in step S**605** whether the wireless communication currently not in the sleep state has been started on the port device **101** side.

The wireless communication started on the port device **101** side indicates that the port device **101** side reads out data from the mobile device **102** side, thereby achieving the data transmission between the mobile device **102** and the port device **101**.

If the port device **101** determines in step S**605** that the wireless communication has not been started on the port device **101** side, the process advances to step S**607**. If the wireless communication has not been started on the port device **101** side, the mobile device **102** side calculates a next sleep period. Therefore, the port device **101** recognizes the sleep period by receiving the information on the sleep period transmitted from the mobile device **102**.

In step S**607**, the port device **101** receives the information on the sleep period transmitted from the mobile device **102**. Consequently, the information on the next sleep period is shared with the mobile device **102** (**404** in FIG. **4**).

Alternatively, if the port device **101** determines in step S**605** that the wireless communication has been started on the port device **101** side, the process advances to step S**606**. If the wireless communication has been started on the port device **101** side, the port device **101** can recognize a data amount to be read out, and therefore calculate a period (an active period) necessary for the readout process. Since the NFC data transmission period **310** is constant as described above, the port device **101** can calculate a next sleep period **312** on the basis of the difference between the NFC data transmission period **310** and the active period **311**.

In step S**606**, the port device **101** calculates the next sleep period, and transmits the calculation result to the mobile device **102**. Consequently, information on the next sleep period is shared with the mobile device **102** (**404** in FIG. **4**).

Similarly, if the mobile device **102** determines in step S**505** that the wireless communication currently in the active state has not been started on the mobile device **102** side, the process advances to step S**507**. If the wireless communication has not been started on the mobile device **102** side, the port device **101** side calculates a next sleep period. The mobile device **102**, therefore, recognizes the sleep period by receiving the information on the sleep period transmitted from the port device **101**.

When the processes in step S**506** or S**507** and step S**606** or S**607** end, and the information on the sleep period is shared, the mobile device **102** advances the process to step S**508**, while the port device **101** advances the process to step S**608**.

In step S**508**, the mobile device **102** stops receiving a charging power. In step S**608**, the port device **101** stops supplying the charging power. Since a time point (**404** in FIG. **4**) at which sharing of the information on the sleep period is completed falls within the active period (transmission period), the charging power supply process and the charging power receiving process are in a stop state. In steps S**508** and S**608**, therefore, this state is maintained.

When the data transmission from the mobile device **102** to the port device **101** is completed (**405** in FIG. **4**), the active period **311** ends, and the sleep period **312** starts.

In this case, the mobile device **102** determines in step S**504** that the current wireless communication state is not the active state, and the process advances to step S**509**. Similarly, the port device **101** determines in step S**604** that the current wireless communication state is the sleep state, and the process advances to step S**609**.

In the step S509, the mobile device 102 determines whether it is in a state in which charging of the secondary battery 219 is unnecessary. The state in which charging of the secondary battery 219 is unnecessary refers to a state in which the charge level of the secondary battery 219 is sufficient or that in which the charge level is in a critical state. Assume that, for example, a charge amount or secondary battery electromotive force is measured, and then whether the charge level is sufficient is determined based on the measurement result. Assume also that, for example, the surface temperature of the secondary battery 219 is measured, and then whether the charge level is in a critical state is determined based on the measurement result.

If it is determined that charging of the secondary battery 219 is unnecessary, the mobile device 102 notifies the port device 101 of it.

In step S609, the port device 101 determines based on the presence/absence of the notification whether the mobile device 102 is in the state in which charging of the secondary battery 219 is unnecessary.

If it is determined in step S509 that charging of the secondary battery 219 is unnecessary, the mobile device 102 advances the process to step S502 to instruct the charge controller 218 to stop receiving the charging power. The charge controller 218 stops receiving the power at the charging power receiving unit 217 on the basis of the instruction. The port device 101 advances the process to step S608 to instruct the charging power supply unit 207 to stop supplying the charging power. The charging power supply unit 207 stops supplying the charging power on the basis of the instruction.

Alternatively, if it is determined in step S509 that the mobile device 102 is not in the state in which charging of the secondary battery 219 is unnecessary, the mobile device 102 advances the process to step S510 to start receiving a charging power. The port device 101 advances the process to step S610 to start supplying the charging power (406 in FIG. 4).

When the sleep period 312 ends, an active period starts. The above-described processing is repeated.

As is apparent from the above explanation, in this embodiment, within an NFC data transmission period, a period other than an active period during which wireless communication processing is executed, i.e., a sleep period is assigned to power supply.

Furthermore, during an active period, a next sleep period is calculated, information on the calculated sleep period is transmitted, and the information on the next sleep period is shared between a port device and a mobile device.

As described above, by automatically executing a process of exclusively controlling wireless communication processing and charging processing within an NFC data transmission period, it is possible to achieve the stable operation of a mobile device while maintaining communication quality in this embodiment.

Second Embodiment

In the above-described first embodiment, each of the port device and the mobile device has the charging induction coil unit and wireless communication induction coil unit, separately. The present invention, however, is not limited to this.

Since the NFC communication means and the power transmission means are controlled to exclusively operate, an induction coil unit may serve as both the charging induction coil unit and the wireless communication induction coil unit, and may be switched to operate as the NFC communication means or power transmission means. The details of this embodiment will be explained below.

1. Functional Components of Communication Device

FIG. 7 is a block diagram showing the functional components of a port device 101 and mobile device 102 according to this embodiment. Note that different points from the functional components (FIG. 2) of the port device 101 and mobile device 102 which have been described in the above first embodiment will be explained.

The port device 101 according to this embodiment has only one induction coil unit 700. The port device 101 also includes a circuit selector (switching means) 701 connected to an NFC chip 702 and charging power supply unit 707. The circuit selector 701 is configured to switch a connection with the induction coil unit 700.

With this arrangement, the port device 101 operates to switch the induction coil unit 700 to the charging power supply unit 707 side, and supply a charging power to the mobile device 102 via the induction coil unit 700 during a sleep period (non-transmission period). The port device 101 operates to switch the induction coil unit 700 to the NFC chip 702 side, and execute data transmission with the mobile device 102 via the induction coil unit 700 during an active period.

Similarly, the mobile device 102 according to this embodiment has only one induction coil unit 710. The mobile device 102 also includes a circuit selector 711 connected to an NFC chip 712 and a charging power receiving unit 717. The circuit selector 711 is configured to switch a connection with the induction coil unit 710.

With this arrangement, the mobile device 102 operates to switch the induction coil unit 710 to the charging power receiving unit 717 side, and receive the charging power from the port device 101 via the induction coil unit 710 during the sleep period. The mobile device 102 operates to switch the induction coil unit 710 to the NFC chip 712 side to switch the connection with the induction coil unit 710, and execute data transmission, with the port device 101 via the induction coil unit 710 during the active period.

2. Details of Wireless Communication/Charging Processing

The details of wireless communication/charging processing between the port device 101 and the mobile device 102 will be described next with reference to FIGS. 8 and 9. Note that only different points from the wireless communication/charging processing between the port device 101 and the mobile device 102 which has been explained in the above first embodiment will be described.

In step S810, the mobile device 102 according to this embodiment switches the circuit selector 711 to the charging power receiving unit 717 side, and then starts receiving a charging power.

After the mobile device 102 stops receiving the charging power in step S808, the process advances to step S811 to switch the circuit selector 711 to the NFC chip 712 side.

Similarly, in step S910, the port device 101 according to this embodiment switches the circuit selector 701 to the charging power supply unit 707 side, and then starts supplying a charging power.

After the port device 101 stops supplying the charging power in step S908, the process advances to step S911 to switch the circuit selector 701 to the NFC chip 702 side.

As is apparent from the above explanation, in this embodiment, an induction coil unit serves as both the charging induction coil unit and the wireless communication induction coil unit, and is switched to operate as the NFC communication means or power transmission means. This makes it possible to downsize the mobile device and port device.

Third Embodiment

In the second embodiment, each of the port device **101** and the mobile device **102** has one induction coil unit which serves as both the charging induction coil unit and the wireless communication induction coil unit. The present invention, however, is not limited to this.

For example, an induction coil unit may serve as both a charging induction coil unit and a wireless communication induction coil unit in a mobile device **102**, and a charging induction coil unit and a wireless communication induction coil unit may be separately provided in a port device **101**.

Alternatively, an induction coil unit may serve as both the charging induction coil unit and the wireless communication induction coil unit in the port device **101**, and the charging induction coil unit and the wireless communication induction coil unit may be separately provided in the mobile device **102**.

FIG. **10** is a block diagram showing functional components when an induction coil unit serves as both the charging induction coil unit and the wireless communication induction coil unit in the mobile device **102**. FIG. **11** is a block diagram showing functional components when an induction coil unit serves as both the charging induction coil unit and the wireless communication induction coil unit in the port device **101**.

FIGS. **10** and **11** show the same functional components as a combination of the functional components shown in FIG. **2** and those shown in FIG. **7**, and a description thereof will be omitted.

The sequence of wireless communication/charging processing between the port device **101** and the mobile device **102** each of which has the functional components is the same as a combination of the flowchart shown in FIG. **5** or **6** and that shown in FIG. **8** or **9**, and a description thereof will be omitted.

As is apparent from the above explanation, in this embodiment, either of a port device and a mobile device has an induction coil unit serving as both a charging induction coil unit and a wireless communication induction coil unit. This makes it possible to achieve downsizing of the corresponding communication device, and to achieve the cost reduction of the other communication device.

Fourth Embodiment

In the above first to third embodiments, which communication device side has started wireless communication currently in the active state is determined, and the communication device which has started the wireless communication calculates a next sleep period. However, a condition for determining which communication device calculates the next sleep period is not limited to this.

To determine which communication device calculates a sleep period, for example, the RAM capacity (memory capacity) of each communication device may be determined, thereby determining the communication device whose RAM capacity is smaller.

Alternatively, whether the operating power supply of either communication device is a secondary battery may be determined. If the operating power supply of either communication device is a secondary battery, the corresponding communication device may calculate a sleep period.

Furthermore, if the operating power supplies of both communication devices are secondary batteries, the remaining levels of the secondary batteries may be measured. The communication device whose secondary battery remaining level is lower may calculate a sleep period.

Other Embodiments

The present invention may be applied to a system including a plurality of devices (e.g., a host computer, interface device, reader, and printer) or an apparatus (e.g., a copying machine, or facsimile apparatus) formed by a single device.

The object of the present invention is also achieved when a computer-readable storage medium which records software program codes for implementing the functions of the above-described embodiments is supplied to a system or apparatus. The above functions are implemented when the computer (or the CPU or MPU) of the system or apparatus reads out and executes the program codes stored in the storage medium. In this case, the storage medium which stores the program codes constitutes the present invention.

The storage medium for supplying the program codes includes a Floppy® disk, hard disk, optical disk, magnetooptical disk, CD-ROM, CD-R, magnetic tape, nonvolatile memory card, and ROM.

The present invention is not limited to a case in which the functions of the above-described embodiments are implemented when the computer executes the readout program codes. Also, the present invention includes a case in which the functions of the above-described embodiments are implemented when an OS (Operating System) or the like running on the computer performs some or all of actual processes on the basis of the instructions of the program codes.

Furthermore, the present invention includes a case in which, after the program codes read out from the storage medium are written in the memory of a function expansion board inserted into the computer or the memory of a function expansion unit connected to the computer, the functions of the above-described embodiments are implemented. That is, the present invention includes a case in which, after the program codes are written in the memory, the CPU of the function expansion board or function expansion unit performs some or all of actual processes on the basis of the instructions of the program codes and thereby implements the functions of the above-described embodiments.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2008-098752, filed on Apr. 4, 2008, which is hereby incorporated by reference herein in its entirety.

The invention claimed is:

1. A power transmission apparatus comprising:

a communication controller configured to communicate wirelessly with a power reception apparatus, during a period capable of data transfer, a duration of power transmission to be performed during a period of no data transfer; and a power transmission controller configured to, after the period capable of data transfer, transmit power wirelessly to the power reception apparatus during the period of no data transfer in accordance with the duration communicated by the communication controller.

2. The power transmission apparatus according to claim **1**, wherein the communication controller starts to communicate the duration and the power transmission controller starts to transmit power in a case where the power transmission apparatus approaches the power receiving apparatus.

3. The power transmission apparatus according to claim **1**, wherein the communication controller transmits the duration information to the power reception apparatus.

4. The power transmission apparatus according to claim **1**, wherein the communication controller receives the information from the power reception apparatus.

5. The power transmission apparatus according to claim **1**, wherein the power transmission apparatus does not transmit power in a case where the communication controller receives from the power reception apparatus a notification indicating that power reception is not required.

6. The power transmission apparatus according to claim **1**, further comprising:

a coil; and

a switch that causes the coil to connect exclusively with the communication controller or the power transmission controller,

wherein the switch causes the coil, based on the duration communicated by the communication controller, to connect with the communication controller during the period capable of data transfer, and to connect to the power transmission controller during the period of no data transfer.

7. The power transmission apparatus according to claim **1**, wherein the communication controller communicates wirelessly with Near Field Communication (NFC).

8. The power transmission apparatus according to claim **1**, wherein the communication controller communicates with the power reception apparatus during a period capable of data transfer in a wireless transmission cycle, and the power transmission controller transmits power to the power reception apparatus during the period of no data transfer in the wireless transmission cycle.

9. A power reception apparatus comprising:

a communication controller configured to communicate wirelessly with a power transmission apparatus, during a period capable of data transfer, a duration of power transmission to be performed during a period of no data transfer; and

a power reception controller configured to, after the period capable of data transfer, receive power wirelessly from the power transmission apparatus during the period of no data transfer in accordance with the duration communicated by the communication controller.

10. The power reception apparatus according to claim **9**, wherein the communication controller starts to communicate the duration and the power reception controller starts to receive power in a case where the power transmission apparatus approaches the power receiving apparatus.

11. The power reception apparatus according to claim **9**, wherein the communication controller transmits the duration to the power transmission apparatus.

12. The power reception apparatus according to claim **9**, wherein the communication controller receives the duration from the power transmission apparatus.

13. The power reception apparatus according to claim **9**, wherein the communication controller transmits a notification indicating the power reception is not required if the power reception apparatus is in a state where power reception is not required.

14. The power reception apparatus according to claim **9**:

wherein the power reception apparatus determines whether the power reception apparatus is in a state where power reception is required or not based on at least one of charging condition of a battery, a power of battery, and a temperature of a battery.

15. The power reception apparatus according to claim **9**, further comprising:

a coil; and

a switch that causes the coil to connect exclusively with the communication controller or the power reception controller,

wherein the switch causes the coil to connect with the communication controller during the period capable of data transfer, and causes the coil to connect to the power reception controller during the period of no data transfer.

16. The power reception apparatus according to claim **9**, wherein the communication controller communicates wirelessly with Near Field Communication (NFC).

17. A control method for a power transmission apparatus comprising:

a communication step of communicating wirelessly with a power reception apparatus, during a period capable of data transfer, a duration of power transmission to be performed during a period of no data transfer; and

a power transmission step for, after the period capable of data transfer, transmitting power wirelessly to the power reception apparatus during the period of no data transfer in accordance with the duration communicated in the communication step.

18. A non-transitory computer-readable storage medium for storing a program which causes a computer to execute a control method, the method comprising:

a communication step of communicating wirelessly with a power reception apparatus, during a period capable of data transfer, a duration of power transmission to be performed during a period of no data transfer; and

a power transmission step for, after the period capable of data transfer, transmitting power wirelessly to the power reception apparatus during the period of no data transfer in accordance with the duration communicated in the communication step.

19. A control method for a power reception apparatus comprising:

a communication step for communicating wirelessly with a power transmission apparatus, during a period capable of data transfer, a duration of power transmission to be performed during a period of no data transfer; and

a power reception step for, after the period capable of data transfer, receiving power wirelessly from the power transmission apparatus during the period of no data transfer in accordance with the duration communicated in the communication step.

20. A computer-readable storage medium for storing a program which causes a computer to execute a control method, the method comprising:

a communication step for communicating wirelessly with a power transmission apparatus, during a period capable of data transfer, a duration of power transmission to be performed during a period of no data transfer; and

a power reception step for, after the period capable of data transfer, receiving power wirelessly from the power transmission apparatus during the period of no data transfer in accordance with the duration communicated in the communication step.

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